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AUTHOR House, J. Daniel
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ABSTRACT

This study focused on gender differences in examining the extent to which Graduate Record Examination (GRE) scores predicted subsequent achievement. Data on 275 graduate students in professional psychology programs at a large midwestern university were collected and analyzed. Two methods for the identification of prediction bias were used and student performance in 10 specific graduate courses was examined. It was found that GRE scores were effective predictors of the graduate course performance of the students. However, for a number of courses, GRE scores under predicted the achievement of female students and over predicted the achievement of male students. Specifically, GRE verbal scores were found to under predict female achievement in four courses, while GRE quantitative scores under predicted female achievement in seven courses. GRE analytical scores under predicted female achievement in four courses, while overall GRE scores under predicted female achievement in six courses. (Contains 48 references.) (MDM)

GENDER DIFFERENCES IN PREDICTION OF GRADUATE COURSE PERFORMANCE FROM ADMISSIONS TEST SCORES: AN EMPIRICAL EXAMPLE OF STATISTICAL METHODS FOR INVESTIGATING PREDICTION BIAS

J. DANIEL HOUSE
NORTHERN ILLINOIS UNIVERSITY

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Gender Differences in Prediction of Graduate Course Performance From Admissions Test Scores: An Empirical Example of Statistical Methods for Investigating Prediction Bias

J. Daniel House

Northern Illinois University

Paper presented at the Association for Institutional Research Annual Forum, Minneapolis, Minnesota, May 17-20, 1998.

Abstract

The purpose of this study was to investigate the extent to which Graduate Record Examination (GRE) scores predict subsequent achievement similarly for male and female students. In this study, a sample of 275 students in professional psychology programs was examined. Two methods for the identification of prediction bias were used and student performance in ten specific graduate courses was examined. Evidence of prediction bias was found for seven of the ten graduate courses studied. This study provides an introduction to statistical methods for assessing differential prediction and the results indicate that GRE scores may not predict subsequent achievement similarly for male and female graduate students.

An important focus of higher education assessment has been the evaluation of the predictive relationship between students' entering academic characteristics and their subsequent achievement outcomes. For prospective graduate students, one factor that is given consideration during the admissions process is performance on the Graduate Record Examination (GRE). When considering the validity of the GRE for predicting graduate student performance, there are several criterion measures of achievement that can be assessed (Hartnett & Willingham, 1980). GRE scores have been found to significantly predict grade performance for graduate students in education (Camp & Clawson, 1979; Furst & Roelfs, 1979; Kluever & Green, 1992; Omizo & Michael, 1979), social work (Milner, McNeil, & King, 1984), public administration (Oldfield & Hutchinson, 1997), biological sciences (House, Gupta, & Xiao, 1997), and more broadly defined academic disciplines (Thornell & McCoy, 1985). With respect to graduate students in psychology, GRE scores have been shown to significantly predict grades in specific courses (Goldberg & Alliger, 1992; House, Johnson, & Tolone, 1987; House & Johnson, in press; Huitema & Stein, 1993). Further, GRE scores have been found to predict overall grade point average (Federici & Schuerger, 1974; House & Johnson, 1993b) and degree completion (Holmes & Beishline, 1996; House & Johnson, 1992, 1993a). Dollinger (1989) found that GRE scores significantly predicted the preliminary examinations performance of professional psychology students. Finally, recent research has assessed the predictive validity of the GRE for American Indian/Alaska Native students and found that

test scores were significantly correlated with graduate degree completion (House, 1997). Results from a recent meta-analysis, however, suggest that there are instances where the predictive validity of the GRE is relatively low.

A critical issue in the use of tests for admissions purposes is that test scores predict later performance similarly for all groups of students who take the test. When systematic differences exist in the relationship between the test scores and the criterion measures for various subgroups of students, then prediction bias exists (Kaplan, 1985; Reynolds, 1982). Prediction bias refers to a systematic error in predicting the criterion variable for particular subgroups of students. For example, it is important to determine if GRE scores predict the subsequent achievement of graduate students in psychology similarly for all subgroups of students. In this case, the presence of significant differences between subgroups of students, such as male and female students, in how accurately achievement was predicted from GRE scores would provide evidence of prediction bias.

Two methods have been proposed for the study of bias in the prediction of student achievement from admissions test scores. The first approach involves the comparison of validity coefficients for all subgroups of students, and is sometimes referred to as an examination of differential validity (Jenson, 1980). For example, the correlations between GRE scores and graduate GPA would be computed separately for male and female students and those correlations would then be tested for a significant difference.

Specific statistical methods are available to test for a significant difference between two correlation coefficients (Kleinbaum, Kupper, & Muller, 1988) or for a significant difference between three or more correlations (Edwards, 1984) and these methods have been applied in previous research on differential validity (House, 1994).

A second method used to investigate prediction bias involves the comparison of subgroups of students on the mean error of prediction of GPA from admissions test scores (Reynolds, 1982). This approach involves several steps. First, a regression equation based on the entire sample of students is used to compute a predicted GPA for each student. A residual score (the predicted GPA minus the actual GPA) is then computed for each individual. The mean error for each group of students (in this instance, gender groups) is the mean of the residual scores for each individual in the group (Pedhazur, 1982). For example, the mean error of prediction for male students would be the mean of the residual scores of each male student. Finally, subgroups of students are compared using analysis of variance (ANOVA) to test for significant differences in residual scores, which represents systematic error in the prediction of GPA from admissions test scores. This approach for investigating prediction bias is sometimes referred to as the Cleary model (Hulin, Drasgow, & Parsons, 1983).

There have been a limited number of studies of gender differences in prediction of student performance from admissions test scores. For instance, recent research has assessed gender differences in the prediction of undergraduate grade performance from

admissions test scores (House, 1995a). Further, other research has found that Miller Analogies Test (MAT) scores did not predict subsequent grade performance similarly for male and female graduate students (House & Keeley, 1995). With respect to GRE scores, Kaczmarek and Franco (1986) found that GRE scores and graduate grades were significantly correlated for women but not for men while Kirchner (1993) reported that student gender was not a significant moderator variable of the relationship between GRE scores and graduate GPA. House (1994), however, found significant gender bias in the prediction of cumulative graduate GPA from GRE scores. It has been noted that gender bias should be less likely to be noted in the prediction of grades in specific courses than when the criterion measure is cumulative GPA (McCornack & McLoed, 1988). Consequently, there is a need to investigate the extent of gender differences in the prediction of graduate course performance from GRE scores.

There were three purposes for this study. First, this study was intended to build upon recent research regarding the validity of the GRE as a predictor of studetn achievement (House, 1997). Second, this study was designed to assess the extent to which GRE scores predict subsequent graduate course performance similarly for male and female students; in previous research, it has been found that female students tend to earn grades that are higher than were predicted by their admissions tests cores (House, 1994). Finally, this study provides a demonstration of statistical methods used to assess prediction bias.

Methods

Students

The students included in this study were a sample of 275 graduate students in professional psychology programs (117 in clinical psychology, 82 in counseling psychology, and 76 in school psychology) at a large midwestern university. In this sample, there were 81 male students and 94 female students. Data collected for each student included their GRE scores, Verbal (GRE-V), Quantitative (GRE-Q), Analytical (GRE-AN), and GRE-Total (GRE-V + GRE-Q), and their subsequent grades in ten courses frequently taken by graduate students in these areas: Statistics II, Theories of Learning, Theories of Personality, Theories and Techniques of Counseling, Psychodiagnostics I, Psychodiagnostics II, Clinical Psychology, Seminar in Advanced Psychopathology, Advanced Behavior Modification, and Seminar in Advanced Developmental Psychology. These courses were either program requirements or were suggested electives.

Procedure

The data from this study were analyzed in two ways. First, validity coefficients were computed for the relationship between each GRE score and grade outcomes in each course for the entire sample. Correlation coefficients were also computed separately for men and women and were then compared for equivalence using Fisher's Z-transformation (Kleinbaum, Kupper, & Muller, 1988); this procedure has been used to compare the validity of admissions

test scores for subgroups of students (House, 1989; House & Keeley, 1993).

The second method used to determine prediction bias was to compare students by gender group on the mean error of prediction found for the GRE. A least-squares regression equation based on data from all students was used to compute a predicted GPA for each student. The mean error for each group was the mean of the residual scores. The gender groups were then compared using analysis of variance to test for systematic error in the prediction of graduate GPA from GRE scores (Reynolds, 1982). These procedures were used for each test score (GRE-V, GRE-Q, GRE-AN, and GRE-Total) and for each of the ten graduate courses included in this study.

Results

Descriptive statistics for GRE scores and course grades are presented in Table 1. Data are presented for the entire sample as well as for male and female students. Correlations between GRE scores and course grades are summarized in Table 2. The correlations are broken into four sections, one for each test score. Further, correlations are presented for the entire sample as well as for male and female students. Finally, *Z*-values for the comparisons of the correlation coefficients obtained for male and female students are shown in Table 2. When the entire sample is considered, a number of significant correlations were obtained, indicating that GRE scores were effective predictors of students' subsequent course performance. For instance, GRE-V scores were significantly corre-

lated with grade performance in five courses (Statistics II, Theories of Learning, Theories of Personality, Psychodiagnostics II, and Theories and Techniques of Counseling). Similarly, GRE-Q scores were significantly correlated with students' grades in six courses (Statistics II, Theories of Learning, Theories of Personality, Psychodiagnostics I, Theories and Techniques of Counseling, and Advanced Behavior Modification). GRE-AN scores were significant predictors of student performance in seven courses (Statistics II, Theories of Learning, Theories of Personality, Psychodiagnostics I, Theories and Techniques of Counseling, Seminar in Advanced Psychopathology, and Advanced Behavior Modification). Finally, GRE-Total scores were also significantly correlated with grade performance in seven of the ten courses included in this study.

Considering gender differences in the correlations between GRE scores and course grades (Table 2), it can be seen that a number of significant correlations were found between admissions test scores and later course grades for both male and female students. However, there was only one instance where there was a significant difference between the correlations found for males and females. The correlations between GRE-Q scores and grades in Seminar in Advanced Developmental Psychology were significantly different; in this instance, there was a strong positive correlation found for male students (.566) and a negative correlation found for female students (-.034). Consequently, there was little evidence for differential validity in the prediction of course performance from GRE scores.

Findings from the analyses of gender bias in the prediction of course grades from GRE-V scores are summarized in Table 3 and several significant findings were obtained. Significant differences between male and female students for the mean error of prediction of grade performance were found for four of the ten courses included in this study. For those four courses (Psychodiagnostics I, Theories and Techniques of Counseling, Clinical Psychology, and Seminar in Advanced Psychopathology), female students earned grades that were higher than were predicted by their GRE-V scores and male students earned lower grades than were predicted by their GRE-V scores. In these cases, GRE-V scores significantly underpredicted the course grade performance of female students and overpredicted the grade performance of male students. In addition, although significant differences between male and female students were not found, the same pattern of underprediction of female students' grade performance was found for two additional courses (Seminar in Advanced Developmental Psychology and Psychodiagnostics I).

Results from the analyses of gender bias in prediction of course grades from GRE-Q scores are summarized in Table 4. Several significant findings were noted. Significant differences between male and female students for the mean error of prediction of grade performance from test scores were found for seven courses (Theories and Techniques of Counseling, Clinical Psychology, Seminar in Advanced Psychopathology, Advanced Behavior Modification, Psychdiagnostics I, Psychodiagnostics II, and Seminar in Advanced Developmental Psychology). For each of these seven courses, GRE-Q

scores significantly underpredicted the course grade performance of female students and overpredicted the grade performance of male students. In other words, female students earned grades that were higher than were predicted by their GRE-Q scores and male students earned lower grades than were predicted by their GRE-Q scores. In addition, although significant differences between male and female students were not found, the same pattern of underprediction of female students' grade performance was found for two additional courses (Theories of Learning and Theories of Personality).

Findings from the analyses of gender bias in the prediction of course grades from GRE-AN scores are presented in Table 5 and a number of significant results were obtained. Significant differences between male and female students for the mean error of prediction of grade performance from test scores were found for four courses (Psychodiagnostics I, Theories and Techniques of Counseling, Clinical Psychology, and Seminar in Advanced Psychopathology). For each of the four courses, GRE-AN scores significantly underpredicted the course grades of female students and overpredicted the grade performance of male students. In other words, female students earned grades than were higher than were predicted by their GRE-AN scores and male students earned lower grades than were predicted by their GRE-AN scores. Further, although significant differences between male and female students were not found, the same pattern of underprediction of female students' grade performance was found for one additional course

(Seminar in Advanced Developmental Psychology).

Results from the analyses of gender bias in the prediction of course grades from GRE-Total scores are summarized in Table 6. Several significant results were obtained. Significant differences between male and female students for the mean error of prediction of course grade performance from test scores were found for six courses (Psychodiagnostics I, Psychodiagnostics II, Theories and Techniques of Counseling, Clinical Psychology, Seminar in Advanced Psychopathology, and Seminar in Advanced Developmental Psychology). For each of these six courses, GRE-Total scores significantly underpredicted the course grades of female students and overpredicted the course grades of male students. As was the case for each of the GRE subscores, female students earned grades than were higher than were predicted by their GRE-Total scores and male students earned lower grades than were predicted by their GRE-Total scores. Finally, the same pattern of underprediction of female students' grade performance was found for two additional courses (Theories of Personality and Advanced Behavior Modification) although significant differences between male and female students were not found.

Discussion

There were two main findings from this study. First, GRE scores were found to be significant predictors of the graduate course performance of students in professional psychology programs. These findings are consistent with the results of previous studies

that have found GRE scores to be significantly correlated with several types of academic outcomes, including cumulative GPA, grades is specific courses, examination performance, degree completion, and time needed to complete graduate degrees. Further, GRE scores were significantly correlated with course performance for both male and female students and there was only one instance where the coefficients found for male and female students were significantly different.

The second finding from this study was that GRE scores did not predict graduate course performance similarly for male and female students. For a number of courses, GRE scores underpredicted the achievement of female students and overpredicted the achievement of male students. This pattern is similar to findings when cumulative GPA is the criterion measure of achievement (Linn, 1973; Sawyer, 1986; Zeidner, 1987). However, because it has been suggested that gender bias should not be apparent for the prediction of grades in specific courses (McCornack & McLeod, 1988), the findings of gender bias for the grades earned in specific courses indicate that factors other than simply differential grading standards are involved in the appearance of gender bias.

There are some limitations to the present study. First, only students from one institution were included in the study. Further research is needed to determine if these results would be found for students at other types of institutions. Previous multi-institution validity studies have been conducted for other admissions tests such as the Law School Aptitude Test (Rubin, 1980) and the Graduate Management Admission Test (Zwick, 1993). A second limitation of

the present study is that no analysis was made of the effects of restriction of range. It has been shown that restricting the distribution of admissions test scores to students who have been admitted to graduate study will produce lower than expected validity coefficients (Givner & Hynes, 1979). Previous research has investigated the effects of restriction of range on the predictive validity of the GRE in an actual admissions situation (House, 1983). Finally, research is needed to determine if these findings would be evident for students in academic disciplines other than psychology.

The results of this study suggest a number of directions for further research. For instance, there is a need to determine if the pattern of gender bias found in this study would be noted for students in a variety of disciplines. Previous research has shown that the predictive validity of the GRE can vary considerably for students in different fields of graduate study (Thornell & McCoy, 1985). A second direction for further research would be to assess the improvement in prediction of graduate student performance by combining GRE scores with noncognitive measures. Previous research on undergraduate students has indicated that noncognitive variables are significant predictors of several types of academic outcomes such as grade performance in specific courses (House, 1995b, 1995c, 1995d, 1996) and of withdrawal from college (House, 1992, 1993). Consequently, research is needed to determine if combining non-cognitive variables with GRE scores would result in improved prediction of graduate student performance.

These results indicate that, in some instances, GRE scores are significant predictors of students' subsequent graduate course performance. These findings also indicate that the GRE does not predict subsequent achievement similarly for male and female students. Finally, these results provide a number of directions for further research.

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Table 1

Descriptive Statistics for Test Scores and Course Grades

	All Students		Males		Females	
	Mean	SD	Mean	SD	Mean	SD
Test Scores						
GRE-Verbal	503.3	78.5	494.0	84.7	507.2	75.7
GRE-Quantitative	525.1	85.5	549.9	84.6	514.8	83.9
GRE-Analytical	559.0	95.0	537.0	92.2	568.2	94.8
GRE-Total	1028.4	134.5	1043.8	138.1	1022.1	132.9
Statistics II	3.34	0.65	3.36	0.64	3.33	0.65
Course Grades						
Theories of Learning	3.67	0.50	3.63	0.52	3.69	0.49
Theories of Personality	3.69	0.49	3.62	0.54	3.71	0.47
Psychodiagnostics I	3.63	0.50	3.47	0.55	3.69	0.46
Psychodiagnostics II	3.69	0.46	3.60	0.49	3.73	0.45
Theories and Techniques of Counseling	3.44	0.51	3.32	0.50	3.50	0.51
Clinical Psychology	3.46	0.53	3.23	0.54	3.57	0.50
Seminar in Advanced Psychopathology	3.47	0.51	3.21	0.46	3.59	0.49
Advanced Behavior Modification	3.48	0.54	3.36	0.60	3.52	0.50
Seminar in Advanced Developmental Psychology	3.58	0.60	3.31	0.60	3.65	0.58

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Correlations Between GRE Scores and Course Grades

Course	All Students	Males	Females	z
GRE-Verbal				
Statistics II	.175**	.210	.163*	0.35
Theories of Learning	.176**	.066	.221**	1.13
Theories of Personality	.160*	.061	.202**	0.99
Psychodiagnostics I	.117	-.025	.177*	1.52
Psychodiagnostics II	.138*	-.014	.207**	1.47
Theories and Techniques of Counseling	.237**	.290*	.201**	0.69
Clinical Psychology	-.029	-.251	.125	1.89
Seminar Advanced Psychopathology	.120	.208	.063	0.87
Advanced Behavior Modification	.135	.136	.123	0.06
Seminar Advanced Developmental Psychology	.158	.052	.165	0.37
GRE-Quantitative				
Statistics II	.357**	.209	.428**	1.70
Theories of Learning	.303**	.364**	.301**	0.50
Theories of Personality	.149*	.152	.175*	0.17
Psychodiagnostics I	.143*	.248*	.163*	0.66
Psychodiagnostics II	.090	.189	.075	0.76
Theories and Techniques of Counseling	.130*	.078	.202**	0.92
Clinical Psychology	.002	-.023	.115	0.69
Seminar Advanced Psychopathology	.028	.086	.139	0.32
Advanced Behavior Modification	.338**	.485**	.298**	1.05
Seminar Advanced Developmental Psychology	.082	.566*	-.034	2.18*

Table 2 (Continued)

Course	All Students	Males	Females	z
GRE-Analytical				
Statistics II	.348**	.272*	.389**	0.91
Theories of Learning	.286**	.261**	.290**	0.23
Theories of Personality	.227**	.319**	.173*	1.08
Psychodiagnostics I	.206**	.102	.222**	0.93
Psychodiagnostics II	.103	.104	.072	0.21
Theories and Techniques of Counseling	.137*	.110	.120	0.08
Clinical Psychology	.174	-.003	.180	0.92
Seminar Advanced Psychopathology	.220**	.321*	.118	1.26
Advanced Behavior Modification	.325**	.395**	.259*	0.72
Seminar Advanced Developmental Psychology	.153	.290	.047	0.81
GRE-Total				
Statistics II	.329**	.254*	.364**	0.84
Theories of Learning	.299**	.265**	.320**	0.43
Theories of Personality	.189**	.132	.225**	0.66
Psychodiagnostics I	.160**	.135	.206**	0.55
Psychodiagnostics II	.141*	.102	.172*	0.47
Theories and Techniques of Counseling	.224**	.228*	.246**	0.14
Clinical Psychology	-.017	-.188	.153	0.18
Seminar Advanced Psychopathology	.091	.185	.133	0.31
Advanced Behavior Modification	.294**	.372**	.265*	0.56
Seminar Advanced Developmental Psychology	.141	.349	.081	0.91

*p < .05, **p < .01

Table 3

Gender Differences in Prediction of Course Grades from GRE-Verbal Scores

Course	Mean Error				
	Males	Females	F	df	p
Statistics II	-.038	.013	0.31	1,227	.5801
Theories of Learning	.033	-.009	0.39	1,254	.5309
Theories of Personality	.055	-.017	1.12	1,253	.2909
Psychodiagnostics I	.150	-.063	10.59	1,267	.0013
Psychodiagnostics II	.087	-.033	3.12	1,224	.0785
Theories and Techniques of Counseling	.115	-.050	5.97	1,260	.0152
Clinical Psychology	.227	-.112	11.52	1,116	.0009
Seminar Advanced Psychopathology	.257	-.115	21.32	1,162	.0001
Advanced Behavior Modification	.108	-.043	1.92	1,113	.1686
Seminar Advanced Developmental Psychology	.249	-.072	3.77	1,69	.0563

*p < .05

**p < .01

Table 4

Gender Differences in Prediction of Course Grades from GRE-Quantitative Scores

Course	Mean Error				
	Males	Females	F	df	p
Statistics II	.043	-.024	0.59	1,227	.4442
Theories of Learning	.089	-.032	3.40	1,254	.0665
Theories of Personality	.086	-.030	2.94	1,253	.0876
Psychodiagnostics I	.178	-.075	15.30	1,267	.0001
Psychodiagnostics II	.103	-.039	4.33	1,224	.0387
Theories and Techniques of Counseling	.148	-.064	9.69	1,260	.0021
Clinical Psychology	.227	-.112	11.51	1,116	.0009
Seminar Advanced Psychopathology	.266	-.119	22.73	1,162	.0001
Advanced Behavior Modification	.155	-.063	4.53	1,113	.0354
Seminar Advanced Developmental Psychology	.272	-.079	4.47	1,69	.0381

*p < .05

**p < .01

Table 5

Gender Differences in Prediction of Course Grades From GRE-Analytical Scores

Course	Mean Error Males	Mean Error Females	F	df	p
Statistics II	-.068	.025	1.13	1,227	.2892
Theories of Learning	.012	-.001	0.04	1,254	.8398
Theories of Personality	.038	-.011	0.53	1,253	.4674
Psychodiagnostics I	.133	-.056	8.57	1,267	.0037
Psychodiagnostics II	.079	-.030	2.50	1,224	.1152
Theories and Techniques of Counseling	.113	-.049	5.58	1,260	.0189
Clinical Psychology	.198	-.098	8.83	1,116	.0036
Seminar Advanced Psychopathology	.236	-.105	18.21	1,162	.0001
Advanced Behavior Modification	.060	-.024	0.64	1,113	.4245
Seminar Advanced Developmental Psychology	.225	-.066	3.05	1,69	.0853

*p < .05

**p < .01

Table 6

Gender Differences in Prediction of Course Grades From GRE-Total Scores

Course	Mean Error Males	Mean Error Females	F	df	p
Statistics II	-.001	.004	0.00	1,227	.9743
Theories of Learning	.061	-.020	1.53	1,254	.2166
Theories of Personality	.075	-.025	2.22	1,253	.1377
Psychodiagnostics I	.167	-.070	13.40	1,267	.0003
Psychodiagnostics II	.099	-.037	4.04	1,224	.0455
Theories and Techniques of Counseling	.142	-.061	9.22	1,260	.0026
Clinical Psychology	.225	-.111	11.29	1,116	.0001
Seminar Advanced Psychopathology	.270	-.121	23.79	1,162	.0001
Advanced Behavior Modification	.128	-.051	2.93	1,113	.0895
Seminar Advanced Developmental Psychology	.264	-.077	4.23	1,69	.0434

*p < .05

**p < .01

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